International Grassland Congress Proceedings

XIX International Grassland Congress

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The XIX International Grassland Congress took place in São Pedro, São Paulo, Brazil from February 11 through February 21, 2001.

Proceedings published by Fundacao de Estudos Agrarios Luiz de Queiroz

Presenter Information

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ID # 02-02

FORAGE LEGUME PRESENCE AND GRAZING INTENSITY EFFECT ON NITROGEN DYNAMICS IN *Brachiaria* PASTURES IN THE SOUTH OF BAHIA, BRAZIL

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Abstract

The objective of this study performed in the Atlantic forest region of the South of Bahia (Brazil) was to examine the influence of the presence of the forage legume *Desmodium ovalifolium* in pastures of *Brachiaria humidicola* on the nitrogen recycled through plant litter over stocking rates of 2, 3 and 4 head ha^{-1}. The results demonstrated that the presence of the *D. ovalifolium* in the pasture significantly increased the protein content of the associated *Brachiaria* grass, and the rate and quantity of N recycled through the litter pathway. While had no significant increase in animal weight gain due this legume, the increase in N recycled through the litter pathway should provide an increase in the sustainability of pasture production, especially at the lower stocking rate where the grazing pressure was lower and the proportion of legume was higher.

Keywords: *Brachiaria humidicola*, *Desmodium ovalifolium*, Nitrogen cycling, Pasture sustainability, Plant litter.

Introduction

About 80% of the nearly 80 Mha of pastures planted with African grasses (mainly *Brachiaria* spp.) in the tropical regions of Brazil show some degree of degradation (Zimmer and Euclides-Filho, 1997). Many studies have concluded that one of the principal causes of pasture decline/degradation is the N and P deficiency.

While P is well conserved in the animal/plant/soil system and P fertilization is economically viable for pasture extensively managed, this is not true for N. This means that the introduction of a persistent forage legume is an attractive option for increasing forage production in such pastures. As a contribution towards determining the impact of introduction of a forage legume into *Brachiaria* swards on pasture sustainability, a study was performed in the South of Bahia (Brazil) to evaluate the recycling of N via the plant residue (litter) pathway in grass-only *B. humidicola* and *B. humidicola*/*D. ovalifolium* pastures.

Material and Methods

1. Site: Estação de Zootecnia do Extremo Sul da Bahia (CEPLAC), Itabela, Bahia. (16^{o}39'S, 39^{o}30'W). Soil: Typic Paleudult (0-20 cm: pH 5.5; Ca^{2} 2.2; Mg^{2+} 0.2; K^{+} 0.1; Al^{3+} 0.1 $cmol_c$/kg); P (Mehlich-1) 2.0 mg/kg. Climate: Humid tropical (Annual rainfall 1300 mm, Mean monthly temperatures range from 19 to 29^{o}C).

2. Grazing experiment: *B. humidicola* in monoculture (BH) and mixed *B. humidicola/D. ovalifolium* (BHDO), each under the stocking rates of 2, 3 and 4 animals/ha with 3 replicates were arranged in a completely randomized design. The experiment was

planted in 1987 and grazed continuously from1988 to 1996 by crossbred Brahman steers. More details of this study were given in Rezende et al. (1999).

3. Evaluations:

1. *Forage on offer:* Sampled 10 quadrats of 1 m^2 per paddock every 30 days throughout 1995, and separated into green grass, dead grass, legume, and weeds, dried for >72 h at 65^{o}C and weighed. Three composite samples per paddock were analyzed for total N content using semi-micro Kjeldahl digestion (Urquiaga et al., 1992).

2. *Plant litter:* The deposition and disappearance of plant litter was evaluated every 30 days throughout 1995 in all paddocks (Rezende et al., 1999). Existing litter in the pasture was evaluated by sampling 10 quadrats (0.5 x 1.0 m) randomly positioned per paddocks. After 14 days the litter deposited in the cleared area of each quadrat was collected. Litter samples were dried, weighed and composite samples were analysed for total N content as for the forage on offer. To determine the legume content of the deposited litter two composite samples from each paddock at each of the 12 samplings were analyzed for ^{13}C abundance and total C using a continuous-flow isotope-ratio mass spectrometer. The proportion of C in the litter derived from the legume (%C_{leg}) was calculated from the equation:

$$\%C_{leg} = 100 \times (\delta^{13}C_{Past} - \delta^{13}C_{Br})/(\delta^{13}C_{Leg} - \delta^{13}C_{Br}) \qquad \text{Eqn. 1}$$

where $\delta^{13}C_{Past}$ and $\delta^{13}C_{Br}$ was the ^{13}C abundance of the litter taken from the grass/legume and *B. humidicola* pastures, respectively and $\delta^{13}C_{Leg}$ is the ^{13}C abundance of litter of *D. ovalifolium*.

4. Calculation of N recycled in litter: The rate of mineralization constant (k) of the plant litter was calculated using the equation developed by Rezende et al. (1999) for litter decomposition:

$$k = -\ln [(X_{eq}-X_N)/X_{eq}]/t_N \qquad \text{Eqn. 2.}$$

where X_{eq} and X_N represents the total N in the existing and deposited litter, respectively in the period of t_N days (14). Half life ($t^{1/2}$) of the N in the litter was calculated from the expression:

$t^{1/2} = \ln(2)/k$ Eqn. 3.

Results and Discussion

The presence of the legume in the pasture increased ($P<0.01$) the N content of the green grass from 8.8 to 11.3 g kg $^{-1}$ and of the senescent tissue from 4.0 to 5.4 g kg $^{-1}$, but the stocking rate had no significant effect. Similarly, the N content of the existing and deposited plant litter was significantly increased ($P<0.01$) in the mixed pasture from 6.1 to 8.5 g kg $^{-1}$ and from 6.1 to 8.7 g kg $^{-1}$, respectively. The stocking rate had significant effect ($P<0.05$) on the N content of litter only in the mixed grass-legume pasture litter. The N content litter deposited was 29 and 41 % higher at the stocking rate of 2 head ha^{-1} than at the stocking rates of 3 and 4 head ha^{-1}, respectively, which was reflected of the higher legume content in the deposited litter at the lower stocking rate (Fig. 1).

The amount of existing litter on the soil surface varied little during the year (Rezende et al., 1999) and its N amount averaged 600 mg m^{-2} in grass-only pasture and 830 mg m^{-2} in mixed pasture (Table 1). In only 14 days a mean of 360 mg m^{-2} N was deposited as litter in the grass-only pasture and 520 mg m^{-2} N in mixed pasture, showing that the decomposition of the litter and N mineralization was extremely rapid (k ranged from -0.057 to -0.094 g g^{-1} day^{-1}). The higher quantities of litter N deposited in the grass-legume pastures resulted in increases in the N recycled via litter deposition which ranged from an extra 42 kg ha^{-1} year^{-1} (4 head ha^{-1}) to 155 kg ha^{-1} year^{-1} (2 head ha^{-1}).

The results demonstrated that the presence of the *D. ovalifolium* in the pasture significantly increased the protein content of the associated *Brachiaria* grass, and the rate and quantity of N recycled through the litter pathway. In an previous study was demonstrated that between 40 and 60 % of *Desmodium* N was derived from N_2 fixation (Alves et al., 2000) which explains the higher N inputs in the mixed sward. While this legume had no significant increase animal weight gain (Macedo et al., 2000) , the larger N recycled through the litter pathway should increase the sustainability of pasture production, especially at the lower stocking rate where the proportion of legume was higher and grazing pressure was lower.

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Table 1 - N recycled in litter of *Brachiaria humidicola* and mixed *B. humidicola*/ *Desmodium ovalifolium* pastures grazed at 3 stocking rates during 12 months of 1995.

Pasture	Stocking rate	Mean of N in litter: Existing	Mean of N in litter: Deposited 14 days	Decomp. rate (k)	Half Life	Total N deposited in litter (12 months): Estimate♣ 14 days	Total N deposited in litter (12 months): Corrected+
	head ha^{-1}	------ mg N m^{-2} ------		g g^{-1} day^{-1}	(days)	---- kg N ha^{-1} $year^{-1}$ ---	
B. humidicola	2	705	426	-0.0661	10.5	111.0	170.2
	3	614	374	-0.0691	10.1	97.5	151.1
	4	483	274	-0.0600	11.6	71.3	105.4
	Mean	601	358	0.0651	10.8	93.2	142.2
B. Humidicola/ D. ovalifolium	2	953	676	-0.0936	8.1	176.3	325.0
	3	801	479	-0.0688	10.4	125.0	193.1
	4	736	397	-0.0567	12.4	103.4	149.0
	Mean	830	517	-0.0730	10.3	134.9	222.4
Coef. Variation (%)		28.2	26.7	23.7	16.2	26.7	34.2
Analysis of variance							
Factor: Pasture(P)		*	**	ns	ns	**	*
Stocking rate (L)		ns	*	ns	*	*	*
Interaction P x L		ns	ns	ns	ns	ns	ns

♣ Calculated from ((N-litter deposited in 14 days)/14) x 365

+ Calculated accounting for loss of litter during 14 days of deposition (see eqn 2 and Rezende et al., 1999)

*, ** differences between means significant at $P < 0.05$ and 0.01, respectively; ns not significant at $P < 0.5$.

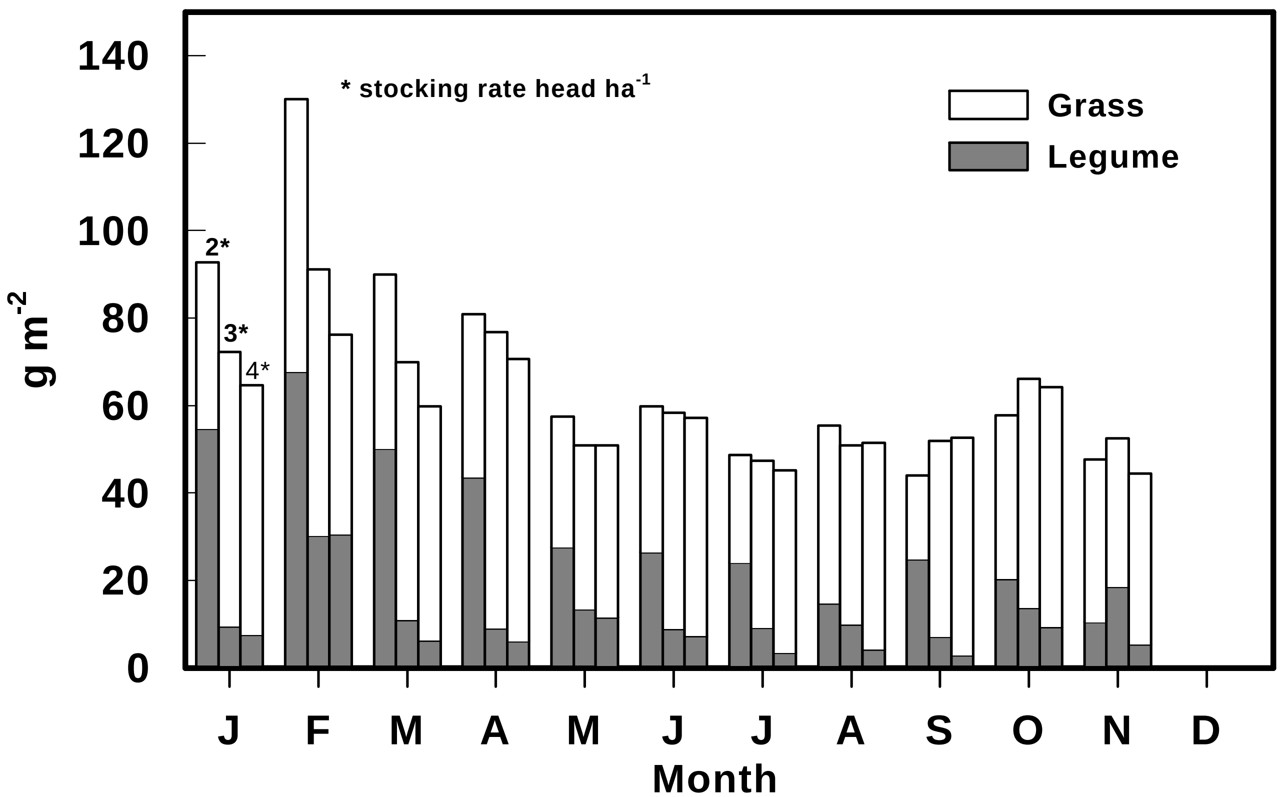

Figure 1 - Dry matter legume and grass of the deposited litter in the mixed B. humidicola/D. ovalifolium pastures at stocking rates of 2, 3 and 4 head ha^{-1} determined from 13C abundance data.